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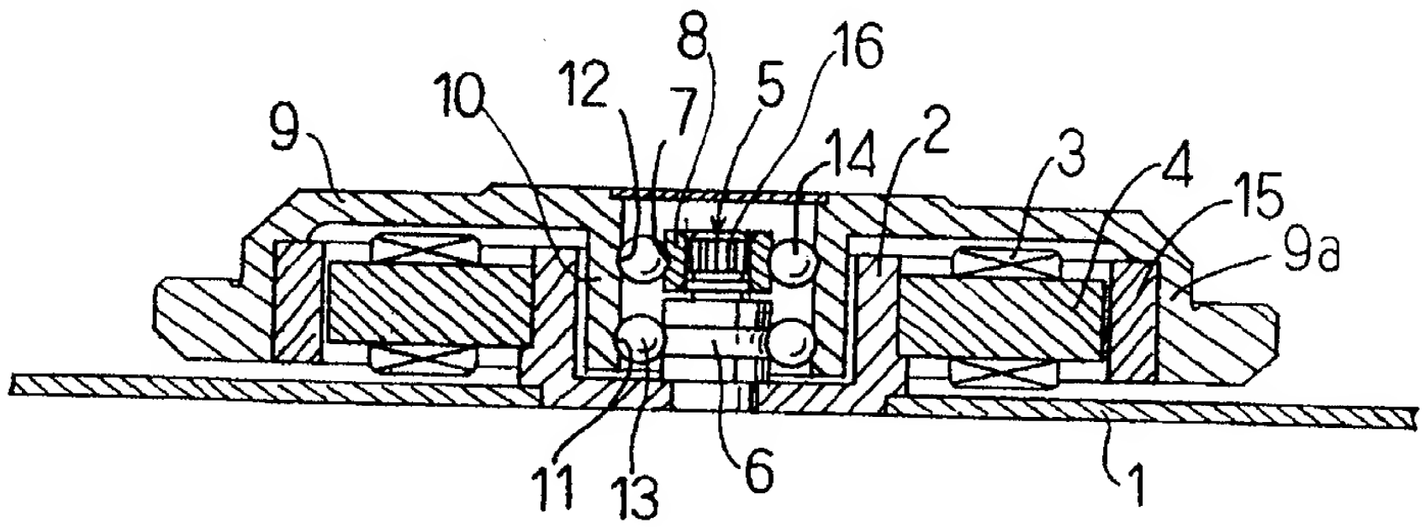
(54) Motor.

(57) In a motor having a spindle (5) on which an inner race (8) of a ball bearing is mounted, an outer peripheral surface of an end of the spindle (5) is formed into a knurled portion (16) on which is mounted the inner race (8) which is fixed to the spindle (5) through an adhesive (18) filling a clearance between an inner surface of the inner race (8) and the knurled portion (16). An annular groove (19), formed in the spindle (5) in an area adjacent to the knurled portion (16), is also filled with the adhesive (18) to further fix the inner race (8) to the spindle (5), which improves the adhesive bond between the inner race (8) and the spindle (5). Even where the ball bearing is a miniature one having a thin-wall inner race (8), there is no risk of deformation of the inner race (8) when the adhesive (18) is cured, and so the rotational accuracy of the motor is improved.

FIG. 1



EP 0 620 633 A1

THE PRESENT INVENTION relates to a machine having a spindle received in a bore of a component thereby fixed to the spindle. The invention is of particular, but not exclusive, utility to the securing of the inner races of rolling element bearings, such as ball or roller bearings, to motor spindles, for example in motors employed in office equipment.

It is known for an inner race of a ball bearing to be fixedly mounted on a spindle of a motor by means including a suitable adhesive, as described below by reference to Figures 5(a) and 5(b) of the accompanying drawings.

Thus,

(a) As shown in Figure 5(a), an annular groove, which is formed between a chamfered outer end portion of the motor spindle and a corresponding chamfered inner end portion of the inner race of the ball bearing, whereby the groove has a V-shaped form in cross section, is filled with the adhesive which is permitted to flow into an annular clearance formed between an outer peripheral surface of the spindle and an inner peripheral surface of the inner race of the ball bearing. The adhesive is allowed to cure in such annular clearance so as to fix the inner race of the ball bearing to the spindle of the motor. However, this first approach is not reliable, because the adhesive supplied to the annular groove often does not flow well enough into the annular clearance formed between the spindle and the inner race of the ball bearing to provide an adequate adhesive bond therebetween.

(b) As shown in Figure 5(b) in an attempt to overcome this difficulty it is known to reduce the diameter of the spindle over an end portion thereof to form a relatively large annular clearance between the outer peripheral surface of the reduced-diameter portion of the spindle and the inner peripheral surface of the inner race of the ball bearing. As a result, the adhesive supplied to the V-section annular groove formed at the end of the spindle/inner race combination can flow readily into this relatively large annular clearance and can be cured therein subsequently so as to fix the inner race of the ball bearing to the spindle of the motor.

In a motor of a normal size, this second approach is adequate, because the annular clearance formed between the inner race and the spindle can be sufficiently filled with the adhesive to provide a good adhesive bond therebetween.

This second approach cannot be used, however, to secure the inner race of a miniature ball bearing to the spindle of a miniature motor, because it has been found that the inner race of the miniature ball bearing can be deformed by forces arising when the adhesive is cured, or that, at any rate, the inner race may be misaligned with respect to the spindle axis after such curing.

It is an object of the present invention to provide a motor having improved rotational accuracy, which motor is free from disadvantages inherent in the conventional motors described above; and, in particular, has an improved adhesive bond between an inner race of a ball bearing and a spindle of the motor whereby the inner race is fixed to the spindle in a reliable manner. It is a further object of the invention to provide a technique in which the risk of deformation of the inner race due to curing of the fixing adhesive is avoided even when the inner race is a miniature one which is extremely thin in wall thickness.

According to the invention there is provided a machine provided with a spindle to which a component having a bore to receive said spindle is fitted, characterised in that said spindle has a portion of an outer peripheral surface thereof received within said inner race knurled, said component being mounted on said knurled portion of said spindle; and a clearance between the surface of said bore of said component and the knurled portion of said spindle is filled with an adhesive through which said component is fixed to said spindle.

Thus, in an embodiment of the present invention a motor is provided with a spindle, an outer peripheral surface of an end portion of which is knurled. An inner race of a ball bearing is mounted on the knurled portion of the spindle. An adhesive is permitted to flow into an annular clearance formed between such knurled portion of the spindle and an inner surface of the inner race of the ball bearing, and is cured therein so that the inner race of the ball bearing is fixed to the spindle of the motor. In the preferred embodiment of the present invention, there is further provided an annular peripheral groove disposed axially adjacent to the knurled portion of the spindle. The adhesive may flow also into this annular groove and fill it to further improve the adhesive bond between the inner race of the ball bearing and the spindle of the motor.

Embodiments of the invention are described below by way of example with reference to the accompanying drawings, in which:-

FIGURE 1 is a longitudinal sectional view of an outer-rotor type motor embodying the present invention;

FIGURE 2 is an enlarged cross-sectional view of the inner race of the ball bearing mounted on a knurled portion of the spindle of the motor of Figure 1;

FIGURE 3(a) is a fragmentary side view to an enlarged scale illustrating the knurled portion of the spindle in one form,

FIGURE 3(b) is a fragmentary side view similar to Figure 3(a) but showing the knurled portion of the spindle in another form;

FIGURE 4 is a longitudinal sectional view of another form of inner-rotor type motor embodying

the present invention;

FIGURE 5(a) is a fragmentary side view similar to Figures 3(a) and 3(b) but showing a conventional mounting of an inner race of a ball bearing on the end of a motor spindle; and

FIGURE 5(b) is a fragmentary side view similar to Figure 5(a) but showing another conventional arrangement.

In the following, there is described, with reference to the drawings, a magnetic disk unit embodying the present invention.

In Figure 1 there is shown in outer-rotor type motor embodying the present invention, in which the reference numeral 1 denotes a base. A sleeve-like yoke holder 2 provided with a bottom portion is mounted on a central portion of the base 1. Disposed around the yoke holder 2 is a stator yoke 4 which is provided with an energizing coil 3.

A spindle 5 has its lower portion fixedly mounted in a centre hole of the bottom portion of the yoke holder 2 and has its upper portion formed into a small diameter shaft portion, so that the spindle 5 is constructed of a lower large-diameter shaft portion and the upper small-diameter shaft portion to form a stepped shaft.

Formed in an outer peripheral portion of the lower large-diameter shaft portion of the spindle 5 is a ball-running groove 6. An inner race 8 of a ball bearing unit is fitted to the small-diameter shaft portion of the spindle 5, and provided with a ball running groove 7 in its outer peripheral portion. A sleeve portion 10 forming an outer race of the ball bearing unit is integrally formed with a rotor 9 and extends downward from a lower surface of a central portion of the rotor 9. Formed in an inner surface of the sleeve portion 10 of the rotor 9 are a pair of ball-running grooves 11 and 12 which are disposed opposite the ball-running grooves 6 and 7, respectively. A plurality of balls 13 are disposed between the ball-running grooves 6 and 11, while a plurality of balls 14 are disposed between the ball-running grooves 7 and 12. As is clear from the above description, the ball bearing unit, which comprises the sleeve portion 10 of the rotor 9, balls 13 and 14, inner race 8 and the ball-running groove 6, serves to mount the rotor 9 rotatably on the spindle 5.

In Figure 1, the reference numeral 15 denotes a magnet which is mounted on an inner surface of a flange portion 9a of the rotor 9 so as to be opposite the stator yoke 4.

At its upper end, the outer peripheral edge of the small-diameter portion of the spindle is chamfered. The outer peripheral surface of the small-diameter portion of the spindle adjacent its free end is knurled as indicated at 16 in Figure 3(a). An adhesive, for example an anaerobic adhesive 18, is permitted to fill an annular groove 17 which is formed between the chamfered portion of the upper end of the small-diameter portion of the spindle 5 and the inner peripheral surface of the upper end of the inner race 8 of the ball bearing. As is clear from Figures 3(a) and 3(b), the annular groove 17 has a V-shaped form in cross section. The adhesive 18 thus supplied to the annular groove 17 flows into the space or spaces defined between the race 8 and the knurled portion 16 of the small diameter portion of the spindle 5. The adhesive is allowed to harden in the space or spaces so as to fix the inner race 8 to the spindle 5.

Various patterns of knurling may be applied to the spindle over the region 16. Thus, the knurling may comprise a pattern of straight grooves in the spindle surface, these grooves running parallel to the rotational axis of the spindle 5 as shown in Figure 1. In a variant, as shown in Figure 3(a), the knurling may comprise a pattern of parallel oblique grooves angled relative to the rotational axis of the spindle 5, and thus extending helically over the surface of the spindle.

In another variant, the knurling may comprise a pattern of two intersecting sets of grooves, each set comprising parallel grooves extending helically around spindle 5, the two sets having equal but opposite pitch angles whereby a pattern or grid of diamond-shapes is defined between the intersecting grooves, as shown in Figure 3(b). Of these patterns, the pattern of straight lines shown in Figure 1 is most preferable.

An additional, peripheral annular groove 19 is formed in the small-diameter portion of the spindle 5 in an area adjacent to the knurled portion 16 of the spindle 5. The adhesive 18 is also permitted to fill such additional annular groove 19 to further improve the adhesive bond between the inner race 8 of the ball bearing and the small-diameter portion of the spindle 5.

It will be appreciated that, prior to curing of the adhesive 18, the inner race 8 of the ball bearing is press-fitted to the spindle 5 from the upper end thereof by applying a force to the inner race 8 so that the inner race 8 is adequately positioned relative to the spindle 5.

Figure 4 shows another form of inner-rotor type spindle motor embodying the present invention. As shown in Figure 4, the spindle 5 constructed of a stepped shaft is mounted in a central hole of a bottom portion of the stator yoke holder 2 so as to extend upward from the bottom portion of the holder 2 which is provided with a sleeve-like rib portion 2a. The stator yoke 4 is mounted on an inner peripheral surface of the rib portion 2a of the stator yoke holder 2.

In the embodiment of the invention shown in Figure 4, the sleeve portion 10 of the main body of the ball bearing unit is integrally formed with the rotor 9 in the lower surface of the central portion of the rotor 9.

The remaining construction of the main body of the ball bearing unit of the embodiment shown in Figure 4 is the same as that of the main body of the ball

bearing unit of the embodiment shown in Figure 1, with the exception of the magnet 15 which is mounted on the outer peripheral portion of the sleeve portion 10 of the ball bearing unit in the embodiment as shown in Figure 4.

In the embodiment of Figure 4 the spindle 5 again has a knurled portion 16 and an annular groove 19 as described in relation to Figures 1 to 3(b) and the inner race 8 of the ball bearing is again fixed to the knurled portion 16 of the spindle 5 through the adhesive introduced between the race 8 and the knurled portion 16 and into the annular groove 19 of the spindle 5.

In the ball bearings of the motors of Figures 1 and 4, the sleeve portion 10 of the rotor 9 also serves as an outer race of the ball bearing. It will be appreciated that, in a variant (not shown), instead of having the outer ball races of the ball bearings formed by an integral part of rotor 9, it would be possible, following more conventional practice, to provide sleeve portion 10 with a smooth bore receiving outer races of individually formed ball bearings each having an inner race push-fitted on the motor spindle. In such a variant, it is still possible for the respective spindle portions received in such inner races to be knurled and grooved and secured to the inner races by adhesive, as described with reference to Figures 1 to 4 herein.

Incidentally, in an inner or an upper surface of the flange portion 9a of the rotor 9, there is provided a printed circuit board connected with the coil 3 for actuating the motor. Alternatively such printed circuit board may be mounted on the inner surface of the base 1 or yoke holder 2. Such printed circuit board is omitted in the drawings for the sake of clarity.

Since the knurled portion 16 of the spindle 5, on which the inner race 8 of the ball bearing is mounted, has its entire outer peripheral surface covered with a layer of the adhesive 18, the adhesive bond formed between the inner race 8 and the knurled portion 16 of the spindle 5 is increased in bonding area and bonding strength, which makes it possible to fix the inner race 8 to the spindle 5 in a reliable manner and improve rotational accuracy of the motor.

Furthermore, even where the ball bearing used in a motor embodying the present invention is a miniature one, there is no risk of deformation of the inner race 8 when the adhesive 18 is cured, because the knurled portion 16 of the spindle 5 has its outer diameter formed within the allowable fitting tolerance of the inner race 8 of the ball bearing. Consequently, it is possible for the present invention to provide a motor with improved rotational accuracy.

The features disclosed in the foregoing description, in the following claims and/or in the accompanying drawings may, both separately and in any combination thereof, be material for realising the invention in diverse forms thereof.

Claims

1. A machine provided with a spindle to which a component having a bore to receive said spindle is fitted, characterised in that said spindle has a portion of an outer peripheral surface thereof received within said inner race knurled, said component being mounted on said knurled portion of said spindle; and a clearance between the surface of said bore of said component and the knurled portion of said spindle is filled with an adhesive through which said component is fixed to said spindle.

2. A machine according to claim 1 characterised in that said spindle is provided with an annular groove around its periphery in an area adjacent to said knurled portion; said component having said bore being mounted on said spindle so as to cover said knurled portion and said annular groove of said spindle; and wherein said annular groove, in addition to said clearance between the surface of said bore and said knurled portion of said spindle, is filled with said adhesive.

3. A machine according to claim 1 which is an inner-rotor type motor and which comprises
   (a) a sleeve-like yoke holder (2) provided with a bottom portion mounted in a base (1);
   (b) a yoke (4) mounted on an outer peripheral portion of said yoke holder (2), said yoke (4) being provided with a coil (3);
   (c) a spindle (5) which is vertically mounted in a central portion of said bottom portion of said yoke holder (2) and which spindle is provided with a lower large-diameter portion and an upper small-diameter portion;
   (d) a ball-running groove (6) formed in an outer peripheral surface of the said lower large-diameter portion of said spindle (5);
   (e) an inner race (8) mounted on said upper small-diameter portion of said spindle (5), said inner race providing a ball-running groove (7) around its periphery;
   (f) a rotor (9) which carries a magnet (15) opposite said yoke (4), said rotor (9) having a lower surface of its central portion integrally formed with a sleeve portion (10) which forms an outer race of ball bearing means mounting said rotor for rotation on said spindle, said sleeve portion 10 being disposed inside said yoke holder (2) and having its inner peripheral surface formed with a lower ball-running groove (11) for receiving a plurality of balls (13) disposed between said lower ball-running groove (11) and said ball-running groove (6) of said large-diameter portion of said spindle (5), said sleeve portion (10) hav-

ing its inner peripheral surface formed with an upper ball-running groove (12) for receiving a plurality of balls (14) disposed between said upper ball-running groove (12) and the ball-running groove (7) of said inner race (8), said ball bearing means including said sleeve portion (10) with said upper and lower grooves (11) and (12) therein, said inner race (8) and said ball running groove 11 on said spindle,

the outer peripheral surface of an upper end portion of said small-diameter portion of said spindle (5) being said knurled portion (16) of said spindle;

said inner race (8) of said ball bearing being mounted on said knurled portion (16) of said spindle and being fixed to said spindle (5) through said adhesive in the clearance formed between said inner surface of said inner race (8) and said knurled portion (16) of said spindle.

4. A motor according to claim 3 wherein said rotor (9) is provided with a peripheral flange portion (9a) which carries said magnet on its inner side.

5. A motor according to claim 3 wherein said rotor (9) carries said magnet on an outwardly directed side of said sleeve portion (10).

6. A motor according to any preceding claim wherein said adhesive is an anaerobic adhesive.

FIG. 1

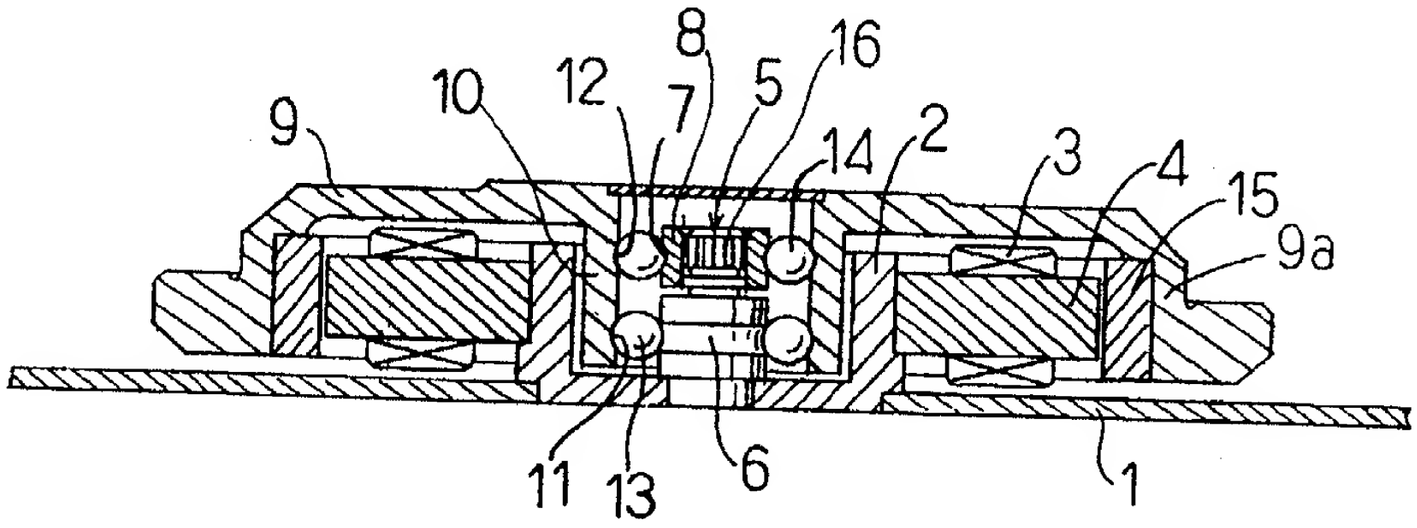


FIG. 2

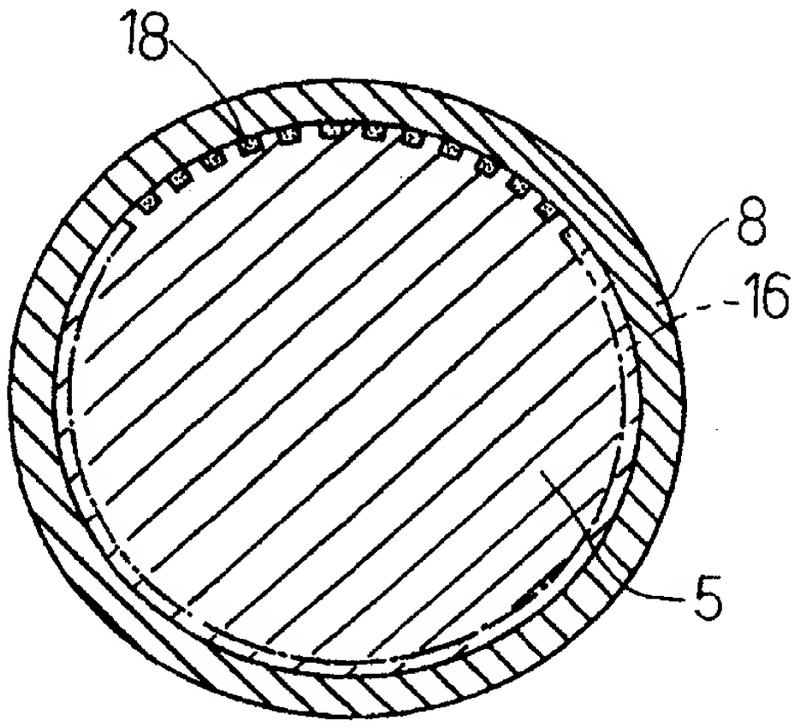


FIG. 3 (a)

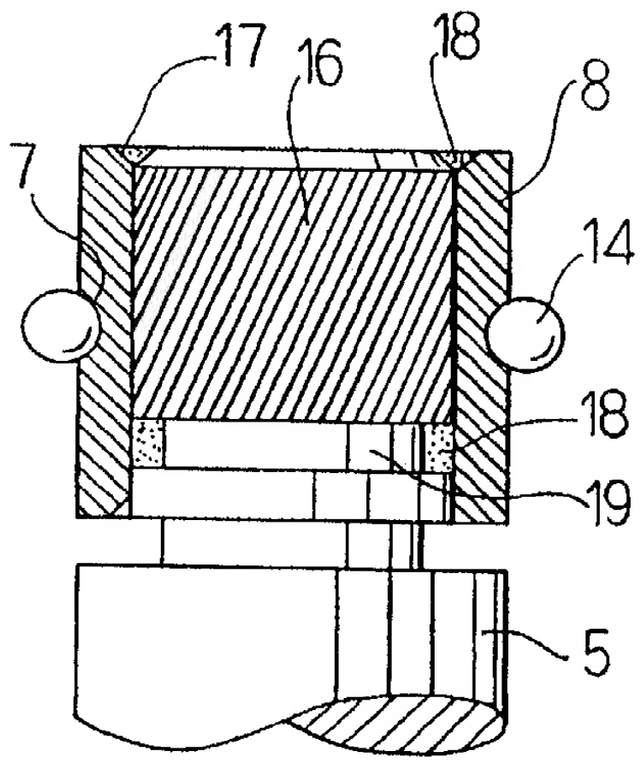


FIG. 3 (b)

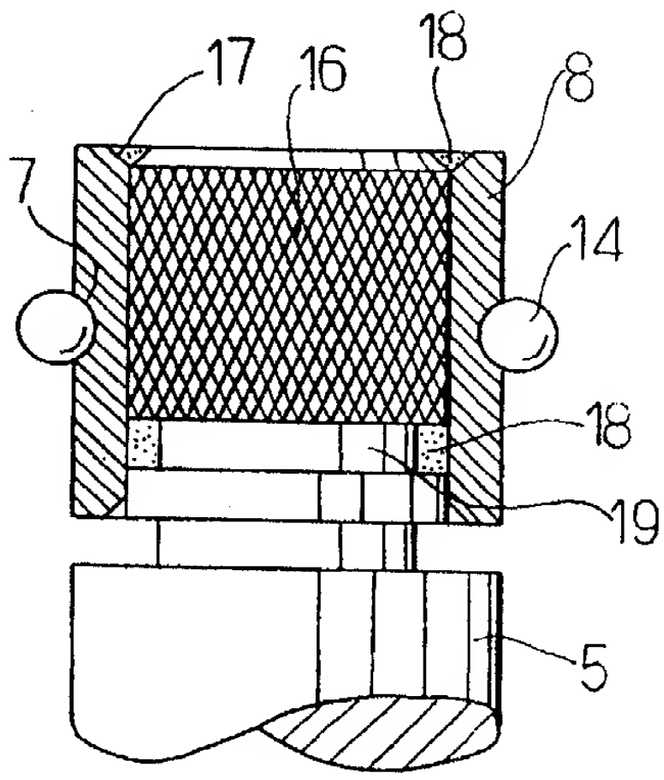


FIG. 4

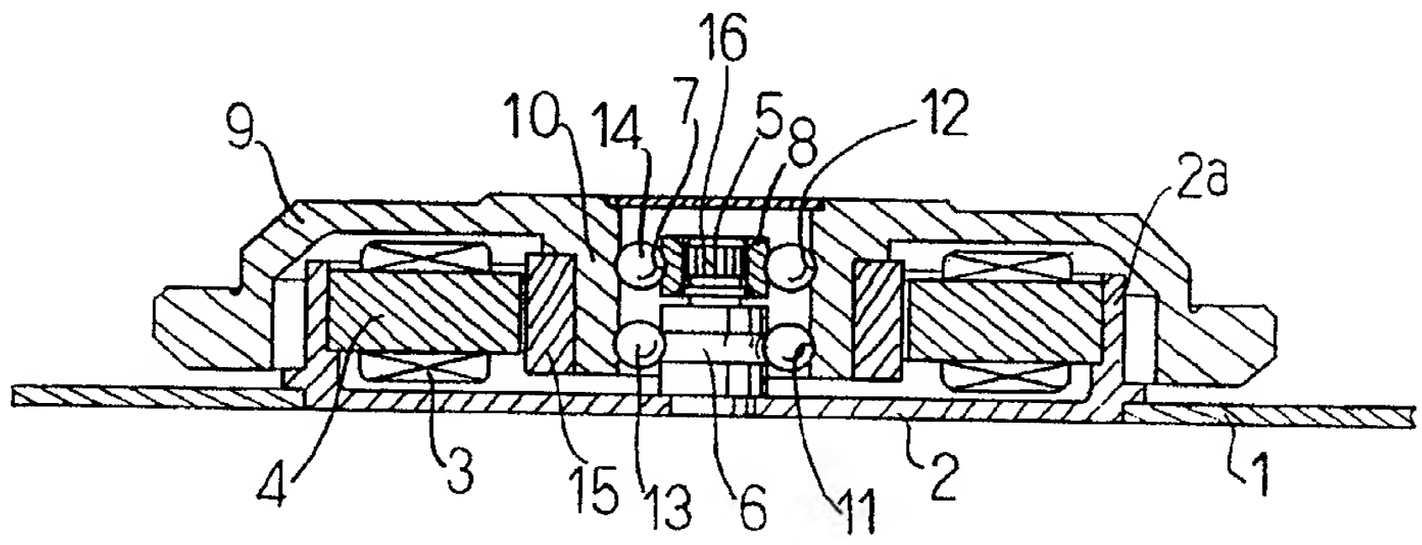


FIG. 5 (a)
Prior Art

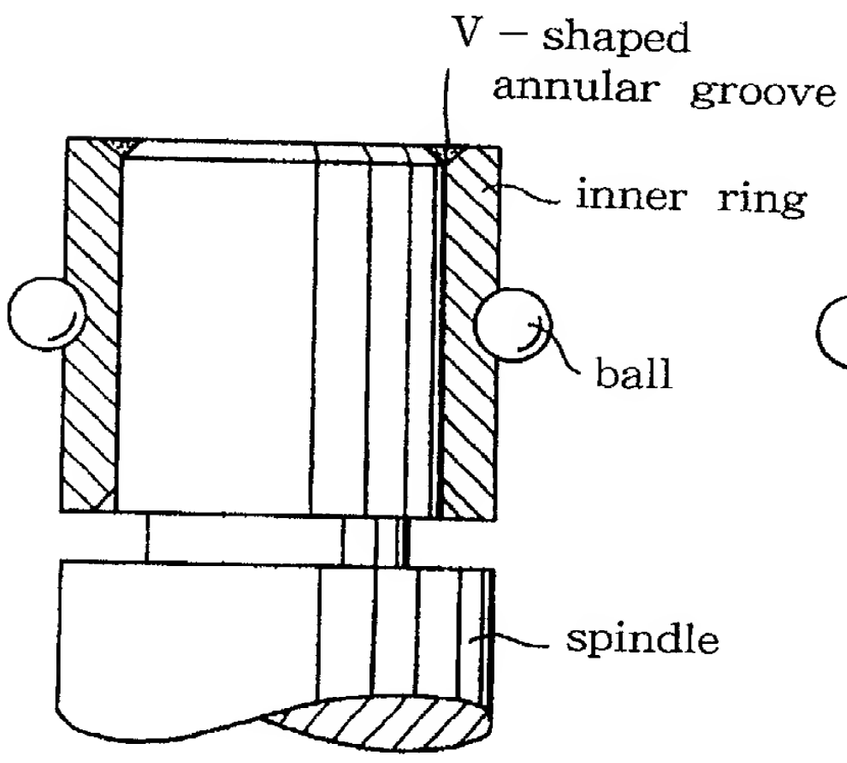
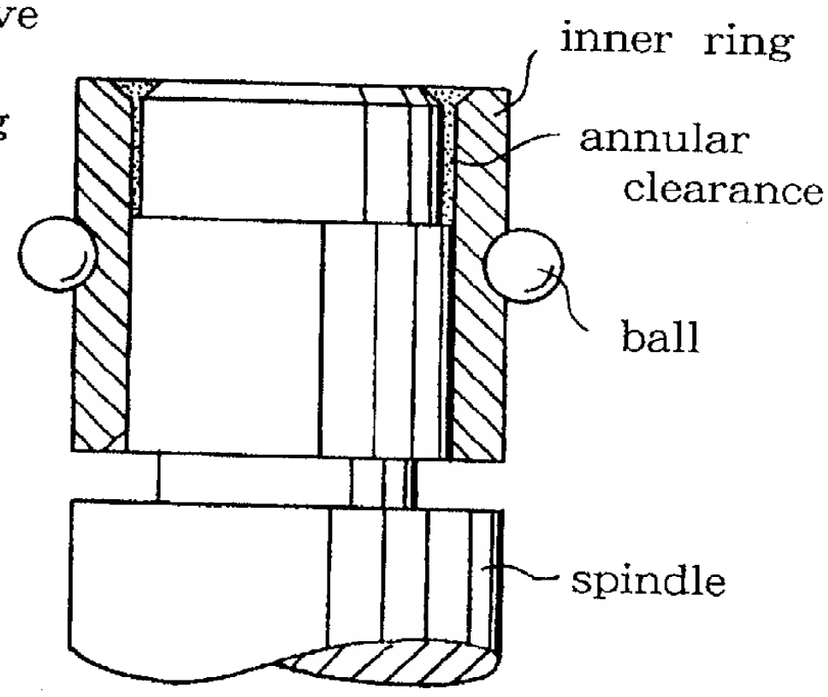


FIG. 5 (b)
Prior Art



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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 2554

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.5)
X	PATENT ABSTRACTS OF JAPAN vol. 16, no. 497 (E-1279) 14 October 1992 & JP-A-41 083 241 (ASMO) 30 June 1992 * abstract *	1,2	H02K5/173 F16D1/06
A	EP-A-0 287 296 (TOSHIBA ET AL) * column 2, line 29 - column 3, line 14; figures 2,4,5 *	1,2	
A	FR-A-2 612 268 (SAINT-MARTIN F.J.J.) * page 2, line 9 - page 3, line 19; figures 4,5,8 *	1,2	
A	US-A-5 138 209 (CHUTA ET AL) * column 2, line 57 - column 4, line 27; figures 1-3 *	3,4	
A	EP-A-0 247 301 (EBM ELEKTOBAU MULFINGEN) * column 4, line 23 - column 5, line 25; figure 1 *	5	
A	DATABASE WPI Week 9227, Derwent Publications Ltd., London, GB; AN 92-225178 & SU-A-1 669 049 (UKRE) 7 August 1991 * abstract *	6	TECHNICAL FIELDS SEARCHED (Int.Cl.5) H02K F16D F16C
A	EP-A-0 269 264 (FERROFLUIDICS CORP.) * column 4, line 31 - column 5, line 2; figure 1 *	3,4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 July 1994	Zoukas, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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